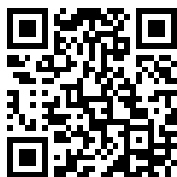

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Report on the harbor of
Charleston

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REPORT

ON THE

HARBOR OF CHARLESTON,

BY
ALEXANDER DILLON
PROF. A. D. BACHE,
Superintendent Coast Survey,

Lieuts. C. H. DAVIS, J. N. MAFFITT, M. F. MAURY, U. S. N., J. D. KURTZ, U. S. E.

TO THE

CHAMBER OF COMMERCE.

CHARLESTON, S. C.:
FROM "THE PRINTING OFFICE" OF COUNCELL & DAGGETT.
1852.

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Jan 21, 1947
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Gentlemen:—"THE Committee on the Improvement of Charleston Bar," appointed by the Chamber of Commerce of our city, have learned, with sincere gratification, your arrival among us, and avail themselves of an early opportunity, to express to you the deep interest which they, and all whom they represent, feel in the purpose of your visit.

The improvement of the Charleston Bar, has long been a subject of great and earnest solicitude, not only to the people of our city, but of the whole State. This solicitude has only become the more intense, now that the increasing connexion of Charleston, by rail roads East, North and West, is rendering her the outlet to a large portion of the exportable products of the surrounding States of North-Carolina, Georgia, Alabama, Mississippi, Tennessee and Kentucky.

The deepening of the Channel of our Bar, therefore, in which but a short time back, this State was alone interested, has now become a matter of almost equal interest to the States already named,—so that any improvement of our Bar, however important to the future welfare and prosperity of Charleston, must now be regarded as a question of general, rather than of local, interest.

Impressed with the importance of this subject, to our own, and to the great and growing interests of so wide a section of our country, the Chamber of Commerce, at the commencement of the operations of the Coast Survey in our harbor, appointed a Committee to communicate with, and to tender its aid in any, and every, way that might be practicable, to the officers having it in charge; in the full hope that the scientific investigations of those engaged in this duty, would point out the way to some feasible plan of improving and deepening the outlets to our harbor.

On the completion of the survey last spring, this Committee lost no time in soliciting your early attention to the object of their wishes, and now would respectfully request of you, a full, patient, and impartial examination of the question—to wit:

Is it practicable, so to improve any one, or more, of the channels of our bar, as to permit the ingress and egress of vessels drawing over sixteen to seventeen feet water—and, if so, at what expense?

We, also, respectfully request, that you will make known to us, any improvements within our harbor, or along our wharves, that may be suggested to you, in the course of your investigations.

Profoundly and gratefully impressed, Gentlemen, with the kind spirit which has prompted your present visit to us, and holding ourselves in readiness to furnish any further information which we may possess, and to make all necessary arrangements to facilitate your operations, and to promote the convenience of your meetings,

We are, with most respectful consideration, &c.

A. O. ANDREWS,
HENRY GOURDIN,
HENRY W. CONNER,
JOHN HEART,
L. T. POTTER,

Committee.

To Professor A. D. BACHE,
Lieut. C. H. DAVIS, U. S. N.
Lieut. M. F. MAURY, U. S. N.
Lieut. J. D. KURTZ, U. S. E.

REPORT.

AT the request of the Chamber of Commerce of the City of Charleston, the undersigned have examined the question of the practicability of deeping the bar, and present, respectfully, the following Report:

The channel ways to the sea from all our sea-port towns between the mouths of the Chesapeake Bay and the Rio Grande, are more or less obstructed by bars. While the commercial wants of the country have called into existence new classes of ships, with improved models and deeper draft, which cannot cross them, the industry and enterprize of our fellow-citizens, have, by rail roads and other improvements, greatly increased the commercial resources of these very ports and harbors, the entrances of which are thus obstructed.

The question, therefore, of increasing the draft which may be carried into these harbors, is one already of great importance; increasing daily in magnitude, it exercises more and more influence upon the business, not only of the rail roads and canals South of the Potomac, but also upon the prosperity of the whole country, and especially upon those portions of it, the industrial pursuits, commerce and navigation of which are suffering so much from these harbor obstructions.

The solicitude manifested, on various occasions, by the General Government, within the last thirty years, to obtain, somewhere, along the Atlantic coast, to the South of the Capes of Virginia, a good man-of-war harbor for the purposes of the common defence, is an indication, not to be mistaken, as well of its views upon this subject, as of the interest with which the great statesmen of the country have never ceased to regard the question of deep water and easy access to one or more of our Southern harbors.

The duty, therefore, of examining into and reporting upon the possibility of increasing the draft which ships may carry over the Charleston bar, has not failed deeply to impress us by reason of its bearings upon so many and such great interests of State. Consequently, we have sought to acquaint ourselves, not only with the present, but also with the past, condition of the bar and harbor of Charleston.

In this part of our duty we have been most kindly assisted by the Committees, both of the State and of the Chamber of Commerce of this city, who have afforded us every facility. We are also under obligations for much valuable information to the surveys and reports which have, from time to time, within the last thirty years, been

made by officers of the army and navy, upon the subject of the harbor and its improvements. The Charts of the Coast Survey and Topographical Engineers have afforded us standards of minute accuracy, and we have felt ourselves greatly indebted to the Pilots and other citizens of Charleston, for much useful information, and very valuable suggestions.

Having thus informed ourselves, and having visited, in person, the proposed scene of operations, we proceeded to discuss the subject freely and fully among ourselves, and to give it the most attentive consideration.

It is proper to state, that we took up the question of increasing the draft of water for ships over Charleston bar, with many misgivings, and not without fear lest any attempt to improve it, might end only in making it worse. But the lights which we have received, from a close and thorough examination, have encouraged us. Impressed with the importance of proceeding cautiously with any plan that could be suggested, these lights have led us to recommend one which, if it do not succeed, can do no harm, and as to the success of which there seems to be a greater amount of probability than with regard to any other that has been proposed.

This plan, therefore, with a statement of the facts, principles and reasons which have led us to recommend it, we beg leave to submit, as one in which we all concur, not only because it seems to us more promising of success on the one hand, but because, on the other, it is the least objectionable in the event of our expectations not being realized.

The spacious and commodious harbor of Charleston is formed by the union of the waters of the Cooper and Wando Rivers, with those of the Ashley, the former flowing on the East, and the latter on the West side of the point of land on which stands the city.

The final place of meeting of these waters is in "Rebellion Roads," which has been very appropriately called the grand reservoir of the harbor. It is a spacious basin, characterised by uniformity of depth and of bottom. From this basin, the waters pass (on the ebb) through a comparatively narrow gorge into the ocean. And here we see repeated the phenomena common to every one of our alluvial *tidal* harbors. In the first place, the force generated by the compression of the water in the gorge, has, in accordance with its uniform law of action, excavated a cavity deeper in spots than any other part of the harbor, occupying a limited space at the outer opening of the gorge, and bounded on the inside by the line of narrowest extent, and on the other by the deposits forming the bar.

In the second place, the water released from its confinement and losing its velocity and movement by diffusion, passes on to the ocean through several drains and channels, more or less deep and regular.

The confinement of the water, at the Narrows, in the harbor of New-York, and its subsequent escape, together with the various channels leading to the sea, furnish an example in which the same causes and modes of action have produced precisely similar results.

These drains or channels may be more or less deep, depending on circumstances, an enumeration of which would lead to very minute explanations, and would be out of place here. We shall pass on to a special description of the bar and channels of Charleston harbor.

CHARLESTON BAR, ITS EXTENT, FORMATION, &c.

Charleston bar is, in general, a deposit of marine sand, varying in its degree of fineness, and mixed, occasionally, with shells. Examination of the quantity of solid matter (sand and the like) contained in the water near the bottom of the sea on the bar, during the flood and ebb tides, shows that it is greatest in amount during the first quarter of the flood. The sand then assumes the qualities of quicksand, and the bar is expressively said by mariners, to be "alive." The sand is precisely such as composes the beach of Long Island to the Eastward of Sullivan's Island, and resembles the shore-sand of the Southern coast generally.

The back water of the inner harbor, and its coves, and of the rivers, issuing with the ebb tide, tends to remove this sand by its scouring action. The relation between the depositing power of the flood and the scouring action of the ebb, determines the position, extent, depth and other general features of the bar. As the velocity and duration of the tidal currents of the ebb are both greater than the corresponding elements of the flood, it might seem that the scouring action should exceed the depositing, but the spread of the waters of the ebb over the larger area of the outer harbor, thus weakening its force, prevents this. The area of a section taken along the curved line crest of the bar, is 47,408 square yards, while that between Cumming's Point and Sullivan's Island, across the entrance, is but 20,178 yards. If this water were confined to its original section, the present bar would certainly be removed, to be deposited elsewhere, when the contraction should cease.

The solid matter brought down by the Ashley and Cooper Rivers, by the ebb tide, is deposited on the flats and shoals of the inner harbor, never, as a general rule, reaching the bar, but being found sometimes in the deeper and more quiet portions of the channels.

The general direction of the tidal currents of the flood along the coast East of Charleston bar, is nearly parallel to the shores of Long and Sullivan's Islands; they set, therefore, directly into the mouth of the harbor, and bluff up against the shores of Morris's and part of Folly Islands. When, by the ebbing of the tide, the water has fallen at the entrance of the harbor—that is, when the flood begins to make, the supply is received not only from the Eastward but the Southward, where also the general set of the tidal currents of flood is to the West. The water is thus forced to change its direction, and when receiving a check to its velocity, it begins to deposit, in particular places, the silt which it contains.

Although the general condition of deposit can be well made out, it is not so easy to anticipate its minute characteristics. The opinion has been advanced, that the existence of an escarpment of marl un-

derlying the bar, is the determining cause of its particular position, and of the depth of a portion of the channels. A careful and extended series of borings, such as has been ordered by the committees of the State of South Carolina and Charleston Chamber of Commerce, cannot fail to furnish the facts to determine this, with other important questions. A deposit once formed would increase, until the general play of the forces causing the deposit should produce a state of more or less permanent equilibrium. It is certain that there would be irregular deposits without such a nucleus from the action of the currents themselves.

The bar is necessarily divided into shoals and channels. The action of currents of water, and of currents of air, is alike; and the inertia both of water and wind, by carrying the current beyond the point of equilibrium, establishes an intermitting action. A regime of deep pools or drains, and dividing ridges, is the natural one of rivers. Such ridges and hills in hillocks, are also the normal regime of a sand area, acted upon by the wind. As an illustration of the effects of this mode of irregular action, we have annexed a profile view of the bar along its crest (plate), which shows its irregular character laterally, and the divisions into shoals and channels. The sections across it are of the same lumpy character. Over the shoals the water passes with a diminished, and through its channels with an increased velocity, furnishing endless sources of change in the forms of the shoals, and of the channels themselves.

The general effect of the conflict of currents in causing marine deposits, will be modified very materially upon a bar of the depth of that of Charleston harbor, by the direction of the prevailing winds, or by violent storms, and for these reasons: First, the tide rising at a mean 5.19 feet, even the bottom of the deepest channels here must be much more than reached by the violence of the waves. Second, the prevailing winds being from the Northeast and Southwest, set across the mouth of the harbor, the first broken by Rattlesnake Shoal and the land of Long Island and Sullivan's Island, and the last by Folly and Morris's Islands. Nevertheless, the swell which they cause outside of the harbor, is in the general direction of the bar itself, and must tend to disturb the channels and shoals very materially. Third, the Southeast wind drives in its swell from the great Atlantic. This swell probably expends its violence more on the shore of Sullivan's Island, than on the bar. These winds also cause a general set of the current near the surface, which likewise tends to produce special changes in the shoaler parts of the bar. Easterly winds may also be included in the list of modifying causes, which affect the deposits upon the bar, for they no doubt force the eddy current from the Gulf Stream towards the mouth of the harbor.

The operations of the coast survey have led to the observation of new and important phenomena in relation to our ocean beaches. One of these, and one very necessary to be considered on the present occasion, is, that the wave of the sea breaks on the shore in a normal direction, coinciding with that of the flood-tide; and this direction is most frequently (speaking of the alluvial coast from North to South)

oblique to the trend of the land. Hence it follows that the motion of translation belonging to that form of wave which finally breaks on the beach, is a progressive motion, and that all the matter held in suspension by the water, and left to its disposition by any cause whatever, is transported slowly but constantly in the prevailing direction in which the final wave of the sea breaks with respect to the line of the beach.

If these facts, and this train of reasoning be, as we believe they are, correct, they leave us in no doubt as to certain channels which it would be very inexpedient, not to say unwise, either to attempt to open or improve. To these we shall have occasion again to refer.

CHANGES IN POSITION AND DEPTH OF CHANNELS.

To ascertain the changes which have taken place in the bar, the chart of 1780, in Des Barrés' *Atlantic Neptune*, that of Lieutenant Sherburne, U. S. N. (1821), of the bar, and of Major Bache, U. S. Top. Engineers, for the outer and inner harbor, in 1825, and that of the Coast Survey in 1851 and 1852, have been compared in the Coast Survey Office. The annexed sketches show the six foot and the twelve foot curves of depth from these maps, (plate, No 1.) There is some uncertainty as to the plane of reference of the oldest. Those of Major Bache and of the Coast Survey, admit of exact comparison, the soundings in the former having referred to the lowest tide observed, and in the latter to mean low water; and the difference between the lowest tide observed, and the mean of all the low waters included in his series of observations having been given by Major Bache. The comparative charts may be otherwise described as exhibiting within the colored spaces, one the depths less than six feet, the other the depths less than twelve feet. The red color refers to the survey prior to 1780, the blue to that of 1821 and 1825, and the black to that of 1851. The curves upon the earliest chart having been drawn from comparatively few soundings, are, of course, to be taken only as a very general view of the configuration of the bottom: it appears to have been the practice in making these charts, to delineate the shoals with as great an extent as the soundings would allow, in order to throw all uncertainties on the safe side—a fact which should be remembered in examining them. It should further be recollected, that only a general expression of the curves is aimed at in the compilation of the sketches. An examination of these charts shows, that according to the earliest records, the bar of Charleston has varied comparatively but little in extent or direction, or in distance from the mouth of the harbor. The channels have varied in number from time to time; but some of them, as the Lawford Channel, Main Ship Channel, North Channel, Sullivan's Island Channel (we have thus called the channel immediately under Sullivan's Island, for the sake of distinguishing it from the other channels), have always been traceable. The positions of these channels have shifted to the Southward, and Southward and Westward respectively, about three-quarters and one-half of a mile since Lieut. Sherburne's

survey, and about two and a half miles, and one mile and a quarter since the work on which Des Barrés' chart is founded, was executed. Before 1780, the six foot curve projected boldly to the Eastward, on a parallel South of Light-House inlet, extending to where the Main Ship Channel is at present. The Lawford Channel of that day was a little to the Eastward and Northward of where the present Main Ship Channel lies. The other channels, except the Sullivan's Island Channel, have been variable in position, and their former positions may easily be confounded one with another. Their value is not such as to justify any detailed discussion at present in relation to them. The North Channel is the least variable of them, and lies three-quarters of a mile to the South of its position prior to 1780, and less than half a mile South of that of 1821. The Overall Channel is now closed towards the Westward. The Sullivan's Island Channel has but slightly changed in position since 1824. It is represented as a mere slue in Des Barrés' chart, probably for want of sufficient soundings to give it the true character. These facts, with others to be presently stated with regard to this channel, agree with the traditions and experience of the intelligent pilots who have freely communicated to us the interesting facts and observations recorded by them.

While the main Ship Channel and the Lawford Channel have thus changed in position to the southward and westward, their depths have diminished. The main Ship Channel, which is given by Des Barrés as a thirteen foot channel, has now less than eleven feet (10.6 ft.) in it at mean low water; and the Lawford Channel, which then had ten to eleven feet in it, has now but eight. Sherburne gives eleven feet in the main Ship Channel and ten feet in the Lawford. It thus appears that these channels, as they have changed their position, have also somewhat decreased in depth. We must, of course, allow something for the uncertainty of the tidal observations on which the oldest charts depend, which may probably amount to about a foot. The scouring action of the ebb tide acts with less advantage as the direction of the channel becomes oblique to the general direction of the current at ebb along the coast. It would not be difficult to trace the result, if this progress continues, until the main Ship Channel has moved so far to the westward as to present its mouth in a direction nearly opposite to that of the tidal current of the ebb. The motion of these channels to the Southward and Westward, is no doubt mainly, if not exclusively, due to the general progress of the deposits in the direction of the flood tide along the coast; but whether this be so or not, the facts are firmly established, independently of the explanation.

The velocity of the current in the main Ship Channel decreases after passing Cumming's Point, increasing again south of Light House Inlet, owing in a degree, perhaps, to the back water of the inlet, but more to the compression of the general current of the ebb south of Folly Island setting the water out against the bar. This tends no doubt to assist in keeping open the main Ship Channel.

The North Channel retains nearly the same depth as prior to 1780; it appears to be rather deeper now than when Major Bache's survey

was made, probably from the effect of Bowman's jetty on Sullivan's Island, and of Fort Sumter flat in causing a more direct action of the current. It had full eight feet at mean low water in 1850, the date of the present Coast Survey chart.

The Sullivan's Island Channel is one of a class presented by many harbors besides Charleston. It resembles, for example, the False Hook Channel at Sandy Hook, New-York, and the Henlopen Channel at the Capes of the Delaware. These are deep channels, closed by a narrow belt of sand, or bulkhead, on which the water is of less depth than in the channel, and connecting them with the cape or hook, where the change of direction in the current causes a deposit. The bulkhead widens out as it recedes from the cape, forming a shoal which separates the channel from the deep water. The channel itself widens as it deepens. Another of the phenomena of tidal harbors like Charleston, observed by the Coast Survey, is the uniform tendency of the channels of such harbors to assume, as one of their natural boundaries at the outlet, or place of discharge, one of the limiting capes or points; that is, the deepest water runs very near the shore.

It has also been observed that, under circumstances of frequent occurrence, the main channel is disposed to follow the course of the land; though this tendency is often interrupted by causes of deposit, such as in general can be easily traced. We have an exhibition of this tendency at Charleston.

The gain of the main Ship Channel towards the land, takes place under the operation of a general law, which has been already stated. Such channels, from their position in regard to the land which gives a protection, are usually quite permanent. The existence of the bulk head and its shoal, shows that there is in such places a constant tendency to deposition, and when the material for deposit is fine sand, a channel of this class, if opened, would be certain to close immediately. The Sullivan's Island Channel has now a depth of fourteen feet, and on the bulk head six feet. Lieut. Sherburne's map shows nearly or exactly the same depth in it. The distance from the fourteen-foot curve on the east side of the bulkhead to the fourteen foot curve on the west side, is 280 yards, measured on the shortest line.

The tidal current of ebb passes more directly out of the North Channel than of the Sullivan's Island Channel, but after the first quarter of the ebb a strong derived current (2.4 miles per hour) sweeps through that channel. The tendency of the current of the ebb to transmit one of its divided streams through this channel, has been exhibited in a very remarkable manner. It is evident from the form of the curves, and the position of the bulkhead, on Major Bache's chart, that this stream formerly ran along the point of Sullivan's Island, in an easterly direction—Bowman's jetty was laid down directly in its path. The stream, however, still seeks to follow its original channel, and though diverted in the beginning of its course, finds that channel by a circuitous route, and with an increased velocity. We regard this as being very favorable to the plan of improvement we shall subsequently present.

The deposit on the bulkhead and shoal, and in the channel is, as far as can be judged in anticipation of the boring, of coarse sand mixed with shells. Such deposits have been found to indicate a more permanent state of equilibrium than those where sand prevails, thus agreeing with the conclusion from the facts already stated in regard to the Sullivan's Island Channel. This feature would be of great importance in relation to any project for making a cut through the bulkhead, both as to the dredging itself and to the probable rapidity of filling up.

Deposits like those forming the bottom of Sullivan's Island Channel, have been fully recognized in the extended observations of the survey of the coast, as characteristic of a condition highly promising to purposes of harbor improvement. They indicate, in the first place, a bottom deep, relatively to the adjacent ground; and in the second place, a state of *comparative* protection or rest—such deposits, moreover, are more easily removed than the fine and compact sand of the bars and shoals, and they are also less rapidly renewed. Proceeding seaward from the bar, the same character of deposit begins to show itself as soon as the water deepens; that is, as soon as the bottom is more seldom disturbed by the action of the waves in storms. This is mentioned as confirming the view that this deposit is characteristic of a greater degree of rest and protection. But the above generalization is the result of observations made on other parts of our coast, where the instances are so constantly repeated as fully to establish its truth.

The channel under discussion is protected to the south east by Drunken Dick shoal, and that causing the North Breakers, from the violence of the southeasterly swell. We have the authority of one of the most intelligent pilots of the bar of Charleston, for saying that in all ordinary blows, there is a smooth sea in the Sullivan's Island Channel.

It has been questioned whether the jettys placed on Sullivan's Island, to prevent the wearing away of the south-western extremity, have affected injuriously this channel, and the question has been carefully examined by us. A comparative chart on a full scale has been made, showing the Sullivan's Island Channel in its connection with the shore, and with the shoal to the southward and westward of it dividing it from deep water, before and after the construction of the jetty. There is a slight uncertainty as to the plane of reference of the chart made in 1841, before the construction of the jetty, which would affect a minute comparison with the Coast Survey chart; but the uncertainty does not materially influence the result which we have under discussion. The channel has been forced slightly further from the land, and the bulkhead has increased in width, but neither it nor the bulkhead has been affected in depth. An interesting feature in the survey of 1852, is the tendency of the deep water on the two sides of the shoal to approach each other, as shown by the deep pocket (20 feet) south by east of the head of the channel, which does not appear in the survey of 1841. Just at the head of the jetty the current has scooped out the bottom to the depth of sixty feet, having encroached upon the bed of eocene marl known to extend across the

harbor from this point to Fort Sumter flats. The deposit of sand on both sides of the jetty, has greatly modified the shore line, to which it has added, at a mean, more than 100 yards. The tendency of the obstruction which this work presents to the ebb is undoubtedly to deflect the water more through the North Channel, and it is one of the considerations going to show the stability of the Sullivan's Island Channel that it has not been more affected by the action of the jetty. No work of engineering could better have effected its purpose of protecting Sullivan's Island from wear than this jetty. That there should have been a question of its effect on the important channel which is under discussion, shows the necessity of studying, in connection, the whole of the problem which the harbor presents. It is worth while to observe here very distinctly, that it is not safe to entertain any projects for special improvements or purposes in a tidal harbor, without a careful consideration of the incidental effects that may follow. The actual state of things can never be disturbed without leading to results that appear to be very remotely connected with the original cause, and, indeed, to any but an habitual student of the motion of tidal currents, entirely independent of it. The British harbors are filled with melancholy examples of the injuries produced by constructions designed solely for special or individual benefit. We may profit by these examples, and still further by the present rule of action in the British Parliament, of allowing nothing to be done in tidal harbors that can alter the established course of the currents, and consequently change the modes of deposit, without the consent and authority of respectable engineers.

ON THE IMPROVEMENT OF THE BAR.

The importance of an easier access to the inner harbor of Charleston, has not failed to render the improvement of the bar and of its channels, a subject of study with engineers and others taking deep interest in the commercial prosperity of the city. These suggestions have not been generally recorded in a permanent form, and, indeed, some of the most valuable have appeared anonymously; and the undersigned have not the knowledge of local history, which would enable them to state these plans or projects in a way to give due credit to their authors.

They have not failed, however, to consider such suggestions as have been made, or as have occurred to them during their examinations of the charts and documents within their reach, and of the communications made to them. They are of opinion, that any improvement of the bar must be tentative, and, hence, have decided upon a project safe in itself, not involving a very heavy expenditure, and which will be very beneficial if successful.

Any attempt to improve the bar with its present extent, by adding to the volume of water thrown into the inner harbor, that is by increasing the reservoir, would, in their opinion, be unavailing. And if artificial works were made for limiting the outside area, now four times that of the entrance, the expense would be very great, and the

bar might be removed from its present position to occupy some other without material change of depth upon it. We do not mean to say that such would necessarily be the case, but merely that until the more feasible and less expensive plan of obtaining access through the Sullivan's Island Channel is tried, no such effort should be made.

At the entrance to Mobile bay, in the same relative position as the Main Ship Channel of Charleston, after the turn at Cumming's Point, several small sand islands exist, the increase of which has forced the water to retain its direct egress from the bay, has limited the spreading on one side, and has forced the bar further out into the Gulf, deepening it materially. The projects for arresting the Southern motion of the channels, and their consequent decrease of depth—for preventing the access of the supply of the shifting material of the bar by a jetty from Long Island to Rattlesnake Shoal—for dredging out the channels of the bar—for promoting deposits on the bar by permanent or temporary obstacles—for forcing the Main Ship Channel from the shore by wattling—for thorough cuts across the land, to be used instead of the ordinary channels of access, all belong to the class which should be undoubtedly postponed until the direct, simple, and moderately expensive experiment which we propose in Sullivan's Island Channel, shall have been made.

This experiment is the dredging of a channel from the Main Ship Channel of the inner harbor to the Sullivan's Island Channel, of the depth of fourteen feet at low water, and nineteen at high. A conjectural estimate of the cost of this operation, has been made by one of us, and is annexed; it will be replaced by a detailed estimate, founded on more specific data, but is believed to be a sufficient approximation in regard to the means required for the action of your committees. The position and form of this cut is shown on the annexed chart. Advantage has been taken of the apparent tendency in the fourteen foot curves to approach at this point to make the cut. The material, as far as is now ascertained, of the bulkhead (coarse sand and broken shells), encourages us to believe that the dredging may be made without great difficulty; but the estimate is founded on the removal of sand, and allowance is made for a comparatively large amount of material to be removed. It is not possible to say whether this channel will remain open, or will require to be dredged from time to time, and at what intervals, nor to what depth it may certainly be made. Should a mere depression in the bulkhead result, as would be very likely to be the case were the material fine sand, then the experiment would be a failure, and attention must necessarily be directed to some other remedy. But the probabilities appear to be, that a cut may be opened, and may be kept open, without an unreasonable outlay of means—say at a cost of one hundred thousand dollars; and we do not hesitate to recommend the attempt. The nature of the work to be done, and of the locality where it is to be executed, require that careful preparation should be made beforehand. The dredging machine best adapted to remove the deposit, the nature of which the borings will fully show, should be selected, the form and construction of the steam engine to work it be duly estimated, and experimental trials be made of the best form and con-

struction of the buckets, and other parts of the machine for the work. Not until the best working machine is prepared, and preliminary experiments have shown how best to use it, and the appliances necessary, should the operations be regularly commenced.

This experiment in dredging will be made at all events under the best circumstances possible for the outer harbor, on account of its nearness to the cove and city, and the shallowness of the depth; and even if it fail directly to furnish a new channel, the experience thus obtained in dredging will be useful in the subsequent trials which must undoubtedly be made. In the course of the experiment it may be found that the best position has not been fixed upon for the cut, or the best form; and by watching the action of the currents, the engineer in charge may be able to devise some plan better than that which can be now framed.

Should the experiment succeed, the channel is admirably placed from its directness, and other qualities already enumerated, to give access to the harbor during all prevailing winds. The portion where beating will be difficult will be small, and to vessels towing from or to sea, it affords every desirable facility.

ON THE IMPROVEMENT OF THE INNER HARBOR.

This subject has been so ably handled by the officers of engineers who have been engaged in the erection of the works for the defence of the harbor, that it is merely necessary to refer to their reports, and to printed extracts from the more recent ones. The jetty work on Sullivan's Island has been entirely successful for the purposes for which it was intended. There remains the improvement of stopping Hog Island Channel, and of protecting the bank near Fort Johnson. Sumter flats appear to be filling up so rapidly, that it will be unnecessary to assist the action there as a general thing. The stopping of Hog Island Channel, will throw the water of the Ashley over against the wharves, increasing its force and velocity. This may occasion some slight inconvenience to navigation, and may render it necessary to give some additional support to the wharves most exposed to its effects. We have no hesitation, however, in saying, that this measure is indispensable to the security and maintenance of the commercial accommodations of the city. The Sumter flats tend to throw the water towards the cut which we propose, into the Sullivan's Island Channel.

The effect of the breakwater on the cut when made, should be observed with the greatest care and minuteness. [See page 30.]

We have also appended a copy of a letter from the Chamber of Commerce of Charleston, requesting us to make the examinations referred to in this report; to do which, we were duly authorized by the departments of the government under which we are serving respectively.

A. D. BACHE, Superintendent Coast Survey.
J. N. MAFFITT, U. S. N.
J. D. KURTZ, U. S. A.
M. F. MAURY, U. S. N.
CHARLES HENRY DAVIS, U. S. N.

A DESCRIPTIVE MEMOIR OF CHARLESTON HARBOR,

By Lieut. Maffit, U. S. N., Assistant in the Coast Survey.

The deterioration of the Main Ship Channel, and general unfavorable changes of the Bar of Charleston, S. C. are such, as not only to attract attention, but also, to excite a reasonable alarm in the minds of her citizens for the safety of her foreign commerce.

By careful comparison with the oldest charts, and consulting with the most experienced and intelligent pilots, it is made manifest, that all the channels have not only decreased in depth, but have changed unfavorably in position.

An investigation of Des Berrés' Chart of 1780, will show, that more than 13 feet water could be brought in, over the main entrance, at low tide. In 1817, the mean depth, on the bar, by Sherburne's Chart, was 12.5; and, in 1851, only 10.7, is to be found on the main bar, at mean low water.

This information, which is corroborated by other evidence, imparts no hope for an improvement by the action of nature; and the demands of commerce call for artificial means to be adopted, even though the effort should result in but temporary benefit; for it may be many years ere such authentic information can be accumulated as will enable the scientific community to ascertain, satisfactorily, the law which governs the action of nature, and produces the alarming changes on the shore, and in the channel ways.

Charleston Bar extends from Sullivan's Island, in a southerly direction (and somewhat parallel to Morris' Island) with a gradual westwardly curve, eleven miles, until it connects with Folly Island, three miles south of Light House Inlet.

The *average* breadth of the bar, from the interior to the exterior two fathoms curve, is one and three quarters of a mile; the greatest breadth, due east of Fort Sumter, is three and a half miles; the least breadth, east from the Light House, is half a mile. There is much irregularity in the breadth, as well as in the configuration, of the shoals.

Numerous channels intersect the bar, nearly at right angles, and the shoals, generally, have a broken surface. *But two* of the channels are *now* available—the *North and Main Ship*: the former is E. by S. from Fort Sumter, and through it all the Northern coasting trade passes. It is narrow, with dangerous shoals on the north and south. Three buoys designate the passage, but the absence of lights prevents its use at night.

Two beacons were erected on Morris' Island, to give a range in, through the Overall Channel, south of the North. In 1817, ten feet was the mean low water, but in 1851, important changes are shown to have occurred; a six feet shoal now blocking up the west mouth of this channel, which has rendered it useless to navigation.

The most important, and through which all the foreign trade of Charleston passes, is the *Main Ship Channel*, located three miles

north from the southern extremity of the bar, and S. E. from the light house; this channel is the best and most narrow of all the passages out or in.

Three buoys designate the locality of the deepest water, and a beacon is erected which, with the Charleston light, gives a range that enables the navigator to cross the bar at night with safety; when inside, the beacon lights back of Fort Moultrie mark out the channel up to Cumming's Point.

The improvements of lights, beacons and buoys, as suggested by the "Board on Light Houses," &c. for the advantage of Charleston harbor and bar, are necessary, and would materially tend to the benefit of navigation.

The water from the Cooper River rushes in a south-eastwardly direction, until checked by a shoal, projecting from the main land, called Oyster Point; deflected from thence, it impinges on the Charleston side, cutting out a narrow, but deep passage, called Town Creek, between Drum Island and the main land. The water, which does not pass through this channel, shoots to the northward of Drum Island, and speedily mingles, in a south-eastwardly course, with that of the Wando.

At the southern extremity of Drum Island, all the waters of the Cooper and Wando are united, and pass together towards the city. It is probable that the extension of the northern wharves, as well as the current from the Wando, deflects a portion of this water from its regular course, through a channel north of Folly Island, called Hog Island Channel.

By a comparison with the maps of Des Barrés, of 1780, Major Bache, 1825, and United States' Coast Survey, 1851, it is made evident, that this channel is rapidly increasing in breadth and depth, which circumstance has created a feeling of anxiety for other parts of the inner harbor; as the loss of so large a volume of water from its natural egress by the city, and westward of Castle Pinckney, may cause a diminution of depth abreast of the wharves, and an increase of the Middle Ground.

The union of the waters of the Cooper, Wando and Ashley, occurs at the west end of the Middle, where they pass on under different influences, to the *grand reservoir* of the harbor—*Rebellion Roads*.

The separation of the tidal current, at White Point, has caused a deposit of considerable extent, which projects out eight hundred feet from the Bath house. The deep water of the Ashley river, with an average of four and a half fathoms, inclines along the city wharves, (the alluvial deposit being great, and spreading out in extensive flats on either shore,) thence glancing off to the southward and eastward, with the direct action of a portion of the ebb from Cooper river, it touches on James Island, with a wasting influence on that beach, from whence it is again deflected, east northwardly, to "Rebellion Roads."

The convergence of the Ashley and Cooper has, no doubt, caused the formation of that troublesome shoal in the centre of the inner harbor, called the "Middle Ground," which extends three-quarters of

a mile west and east, and one-third of a mile north and south—having *at present* more depth than in 1825; the least water *now* is eight feet at mean low water, and six at spring tides. The water from Hog Island Channel, after passing round by Mount Pleasant, in a circuitous direction, unites with that from Sullivan's cove, and empties into Rebellion Roads, where the union of all the waters of Charleston is perfected.

The large body of water compressed in Rebellion Roads, finds its egress oceanward between Forts Sumter and Moultrie with so strong and scouring a force, that it has carved out the bottom here, to the depth of thirteen and fourteen fathoms, finding a foundation of rocks or marl mixed with shells; beyond this point the current spreads over a greater surface, with the strongest tendency through the Sullivan and North Channels. The velocity around and by Cumming's Point is weakened in its southern progress, from a gradual diffusion, at right angles, over the bar. In passing through the main Ship Channel, the ebb is somewhat re-invigorated, probably by the current out of Light House inlet, though its strength is not sufficient to contend successfully with the deleterious action of the ocean current and hammering waves forced in by the north-easterly gales.

A portion of the ebb rejects the main Ship Channel, and passing on to the southward and westward of the South Breakers, makes its exit through the Lawford, which in 1817 was a twelve foot, but *now* a seven foot channel. The flood to the eastward of the bar (in calm weather) sets about east by north—the ebb generally west-south-west. The currents are much influenced, though not controlled, by the prevailing wind; the *average* force of the flood on the bar is 1.2 miles per hour, with a duration of 5h. 40m.—the velocity of the ebb is 1.55 miles per hour, with a duration of six hours; *inside* of the bar, and particularly *in the channel ways*, the current velocity is much greater than *on it*; and *outside*, the velocity is much less.

In the Cooper river, the bottom is generally mud and sand, the average depth being from five to eight and nine fathoms; abreast of Market street wharf the bottom is slaty, consequently the anchorage bad; proceeding further south, the mud increases, and in the Ashley muddy bottom prevails.

Between Folly and James Island, mud and sand characterize the deep water, but fine sand the shoal.

In "Rebellion Roads," mud and grey sand predominate. A short distance south by west of Fort Moultrie, in a line with Cumming's Point, there is a bed of calcareous or limestone rock, which is supposed to extend eastward further than the limits of the bar. If this prove true, the proposition for dredging out the channel will be more attractive from the increased probability of the experiment being successful.

The bar of Charleston is composed of fine grey sand, mixed with black specks, with occasional layers of coarse sand and broken shells. To the eastward of the bar, in deep water, coarse sand and gravel, with broken shells, (and mud occasionally,) constitute the general character of the bottom, except on the "Rattlesnake Shoal;" that is

formed of fine white sand and black specks, corresponding to the deposits on Drunken Dick.

The east three fathom curve of the bar, is uniform and nearly parallel with the coast, but the inside curves are broken, and irregular particularly from abreast of the Overall Beacons, to the westward, which originates from the dredging effects of the ebb tide, exhibiting, greater strength *here* than further south.

The extensive shoals that caused the South breakers, are strung together in the most singular and irregular manner, strongly exhibiting the influence of ocean wave and current action: fine gray sand, with occasional beds of broken shells, denote the character of the bottom.

Along the beach of Sullivan's Island is a channel with fourteen and fifteen feet of water at low tide, except at its inner or Western entrance, by the long jetty South of Fort Moultrie, where is deposited a belt of broken shells and fine sand, with but seven feet upon it.

Adjacent to this belt, to the westward, the depth of water is very great, starting from twenty feet abruptly down to sixty. The ebb tide, in this locality, runs with great force, its average velocity being 2.4 miles per hour; and over the jetty it is very rapid until half ebb, when the exposure of the rocks, by the falling of the water, produces an eddy current favorable to the deposit which the flood tide has already made, increasing the East beach to some considerable extent.

The unfortunate condition of the bar, and manifest anxiety for its benefit on the part of the citizens, has naturally urged upon me (independent of my duty) a close inspection, and considerable reflection, as to the proper locality that might be susceptible of improvement.

My investigation has resulted in the settled conviction, that no feasible or reasonable plan can be adopted for the benefit of any one channel South of Sullivan's Island Channel.

All the rest are alike exposed to the revolutionary action of Easterly gales, which cause an ocean current that conveys and deposits at the mouth of all the channels (except Sullivan's Island) a "bulkhead" of fine sand, which the ebb tide has not sufficient power to disperse; besides this, it will be made manifest that these channels are not only shoalened by marine deposit, but that, under the same ocean influence, they are working further to the Southward.

Due East of Fort Sumter, and three and a half miles from "Breach Inlet," is located a dangerous and important shoal, unconnected with the bar; it trends nearly N. E. and S. W., and is two and a half miles in length, with a breadth of one-eighth of a mile. At spring tides there is but five feet water upon it in several places; it is formed of fine gray sand, with black specks, and has four fathoms close in with it on either side, the bottom changing to coarse sand and broken shells.

This shoal being in the track of all the Northern coasting vessels, is dangerous to navigation, and should be buoyed; yet, undoubtedly it is beneficial to Sullivan's Island Channel, acting as a *breakwater*

in Easterly gales, and protecting it from the injurious influence of the sea.

The trending out to the Eastward of Long Island, and the shoal spit from "Deweese's Inlet," must afford material protection to the above-mentioned channel; while "Drunken Dick," and the bar generally, protects it from the South Eastwardly and South Westwardly gales.

Thus nature affords a shield to the Sullivan's Island Channel, which, in my opinion, warrants a *reasonable expenditure*, in the shape of experiment, the prospect of advantage being not altogether hypothetical. There is one certainty well worthy of consideration—that, if the experiment *here fails*, the other channels cannot be injured by the effort to obtain a better channel way at this point of the bar.

My observation goes to prove that all passages over a sandy formation, have a natural tendency to follow the shore, as is the case with the Sullivan's Island Channel.

The inner barrier, which now renders it unavailable, consists in many places of coarse sand and broken shells; in others, gray and black sand, with a large quantity of mica; under this layer, sand and shells. The distance to be dredged will not be more than one thousand five hundred feet in length, and the quantity necessary to displace for the obtainment of a fourteen feet channel, would not much exceed five million cubic feet of the bottom.

The ebb tide has at present a decided inclination to force a good outlet here; for since the building of Fort Sumter, between that Fort and Fort Johnson the flats have accumulated, and the sand "up-hove" to such an extent as to form a natural jetty, deflecting the ebb towards Sullivan's Island.

I am strongly impressed with the idea, that if this belt, E. S. E. from "Bowman jetty," be dredged to a sufficient depth, the accumulated force of the ebb (from the deep basin alluded to before) will be powerful enough to keep the channel clear; but even with the conviction that in time a re-deposit would occur, I would not be deterred from the *experiment*; for, possessing the "dredging machine," which, when unemployed on the bar, could be hired to the owners of wharves to dredge the docks with, the continuous facility for cleansing would always be on hand, and the passage kept open at a comparatively small expense.

The next channel to notice is the North, which is in a direct line and due E. S. E. of the mouth of "Rebellion Roads," apparently open to the full influence of the ebb, or cleansing current, which would seem to warrant its possessing greater depth than any other channel on the bar. This, however, is not the case; for, being exposed to the influences before-mentioned, it is injured by a "bulkhead" of fine sand athwart its Eastern mouth, with but eight feet water at mean low tides, and six at spring.

One-half a mile South of the North, and parallel, is the Swash Channel, which possesses all the characteristics of direction, bottom, depth, and formation, as the former.

The next channel is the "Overall." In 1817, this channel was

more available than the North, the beacons in range leading into nothing less than ten feet at low water; but at present a narrow crest of fine sand, with only six feet at mean low water, has formed across the inner mouth, to the almost total uselessness of the passage.

Adjacent to the "Overall" is the "Coast Survey Channel," called the "New Middle." It was discovered by the hydrographical party under my command in 1850, and eleven feet at mean low water could be carried through without difficulty. The character of the bottom, and lumpy spots in many places, rendered its permanency doubtful; and orders were wisely issued for repeated examination (as the opportunity offered), ere a final report of its character should be made.

In January, 1851, when re-examined, no material change was obvious; but in February, 1851, a small vessel was wrecked a few hundred yards North of the West entrance. She bilged, and drifted into this channel, sinking in eleven feet water. Ere she broke up and drifted away, a six feet shoal formed around her, and by the recent re-survey of January, 1852, a narrow belt of sand was found to have banked up athwart the East entrance, making a six feet shoal, where, in 1850, eleven feet at mean low water existed. These changes were not altogether unexpected, from the loose nature of the sand composing the bottom, and particularly as the location of the channel was unfavorable for the scouring action of the ebb tide. It is but proper here to mention circumstances of considerable interest that were made manifest while obtaining the set and velocity of the currents in this channel. Finding that the anchor did not hold on the flood, the moorings were doubled, and the bottom sounded with a pike. The sand seemed all alive, and appeared to travel in with the tide; when the ebb made, the bottom at once hardened down, and no impression could be made with the pike. Specimens of the water at different stages of the tide, were, in consequence, bottled. Those that I personally examined, gave evidence that on the flood the water was impregnated with fine sand, which was not the case on the ebb. This is but a collateral evidence that all changes on the bar are produced by the flood; and microscopic examination of the specimens of the bottom, proves the deposit to be marine.

From the new Middle Channel, south, the bar narrows, and when about east from the light, a ten foot channel exists now, called the "New S. E. Channel," which on Des Barrés' chart of 1780, appears to have been the main Ship Channel. But the present main Ship Channel is one mile south of this, tending W. N. W. and E. S. E. Like the others, it is exposed, and manifests the destructive influence of the ocean, having a narrow belt of fine sand at the outer mouth, with but 10.6 feet at mean low water and 8.7 at spring tides. The channel is full of lumps, which no doubt originated from the repeated loss of buoy moorings, that became the nucleus of small and troublesome shoals. This channel continues to work to the southward, as is clearly proved from the following circumstance: In 1831 the range beacon for crossing the bar was three hundred and twenty yards to the northward of its position in 1850. In January, 1852, it was again

moved twenty-six yards further south, in order to range with the light for crossing the bar in the best water.

The knowledge of the migratory character of the channel, might have suggested the propriety of a portable beacon in place of the brick one just erected.

South-west from and bordering on the main Ship Channel, there exists extensive and dangerous shoals; and between them lies the last swash or channel on Charleston bar this is called "The Lawford." Two years ago it was buoyed and constantly used by the Savannah steamers; the changes in it have been so injurious, in the last eighteen months, by the increase of shoal ground, that the steamers have abandoned it, and now use entirely the Main.

In May, 1849, I erected a signal on Folly Island, on a bluff some twenty yards from high water mark. In December of the same year I found that it had been washed away; the bluff was submerged, and no trace of the signal left.

In conclusion, I would state that I do not think there is any danger to be apprehended from the action of the ocean, on Sullivan's Island, as the jetties now standing, have had the desired effect of preserving the beach from the sea encroachment. Should there be a doubt on this subject, I would suggest the placing of small jetties along the beach, to extend but a few feet below low water mark, as at Beaufort, N. C., where small stone jetties had the desired effect, under circumstances precisely similar to the beach in question at this place; and the washing of the shore, which was at one time rapid, has been checked by the numerous small jetties erected for its preservation. A few years of observation would show whether these additions are necessary or not. The elongation of the present jetty, does not appear desirable.

In the event of a recommendation being made for the dredging of the Sullivan's Island Channel, I would suggest a re-examination and more elaborate survey on a large scale, for the guidance of the persons who may have the direction and control of a work, which is so vital to the commercial prosperity of the City of Charleston.

All of which is respectfully submitted by

Your ob't servant,

J. N. MAFFITT,

Lieut. Commanding, U. S. Navy.

ABSTRACT OF THE REPORT OF CAPT. A. H. BOWMAN, CORPS OF ENGINEERS, U. S.

On the Improvement of Charleston Harbor, October 11, 1839.

To Col. J. G. TOTTEN:

Sir:—The principal work now in progress in Charleston Harbor, is that designed to protect the site of Fort Moultrie, and to prevent the farther encroachments of the sea upon Sullivan's Island. In the success of this work, Charleston has a deep interest. The destruc-

tion of Sullivan's Island would render this harbor little better than an open roadstead, with no protection against the violent North-east gales so common in this latitude, especially about the time of the Equinoxes. Storms from this quarter are directly opposed to the Gulf-stream, and cause the water to rise to an unusual height, rolling a heavy sea into those harbors that are unprotected. During the gales of 1699, 1728 and 1752, and others at a more recent period, the water rose ten feet above the ordinary high tide, covering the city of Charleston, and compelling the inhabitants to retreat to the second stories of their houses, destroying the wharves and shipping to a ruinous extent. On these occasions the force of the sea was broken by this Island; to the protection thus afforded, the town owed its preservation from still more extensive injury.

The present Fort, erected in 1806, is the third which has occupied the South-west end of the island. The two first, more perishable than the honors acquired in their defence, have been swept away; not a vestige of either now remains above the waters by which they were destroyed. It is not possible to ascertain, with any degree of certainty, the extent of beach that has been washed away. It is, however, probable that some two hundred and fifty yards of the south west point of the Island has been destroyed; of this a portion was marsh, but the greater part light sand, mixed with small particles of mica. Col. Moultrie, in his report of the defence of the fort, says, "there was a morass in the midst of the fort, that swallowed the shells as fast as they fell;" the existence of cypress knees and stumps on the point of the beach at a recent period, shows that the marsh extended even beyond the limits of the fort. This is an important fact connected with the preservation of the Island. The encroachments of the sea may be arrested where we have mud bottom to build upon. The abrasion occasioned by the waves above low water mark, was readily prevented by the system of jetties and crib work commenced in 1830. It was evident, however, if the deep water of the channel continued to approach the shore, that both the crib work and the fort it was designed to protect, must be involved in one common fate, so soon as it should reach them. Before the commencement of the system of jetties, the sea had reached the present fort, and had thrown down portions of two faces of the work. To prevent, if possible, the nearer approach of the deep water, it was resolved to construct grillages, running perpendicular to the direction of the current, and extending from the crib work on shore towards the channel; these grillages to be loaded with rough stone, rising as near to the surface of the water as should be found necessary to cause a deflection of the current from the shore.

It has been stated that the great moving power of the sand was the flood tide; the largest accumulation of sand has consequently been on the sea side of these grillages. On the opposite side the increment was comparatively small. The first gale above referred to, brought the sea with great force upon the mass of sand accumulated on the sea side of the grillage. By the combined action of the waves and

current, a large amount of this sand was washed over the grillage, forming on the harbor side, a bank equal to that on the sea side.

After the gale abated, the accumulation of sand on the sea-side of the grillage, soon attained its former magnitude, the beach on the opposite side, having been increased in breadth about seventy feet; similar results were produced by the second gale.

In compliance with the instructions of the Department to that effect, my attention, during the summer, has been directed to the proposed Breakwater over Drunken Dick Shoal. The protection of Sullivan's Island cannot be regarded as complete, until this work shall be constructed. The grillages, when finished, it is believed, will render the West end of the Island secure, but well grounded apprehensions are entertained that the sea will make a breach through the Island, at a low and narrow place, called the "Curlew Ground," directly North of Drunken Dick Shoal.

The proposed work would at once remove all grounds for such apprehensions, besides securing important advantages to the port of Charleston.

It will cause the extension of Sullivan's Island to the South, and, in a corresponding degree, diminish the force of the sea in the harbor. It will concentrate the water upon the bar of the North channel, and increase the depth; this channel is straight, and would, by these means, be rendered the safest and most accessible entrance.

In his Report of October 17, 1839.

Referring to your letter of August 31st, I find instructions to report "on the present state of the channel between Shutes Folly and Hog Island," &c.

The passage between Shutes Folly and Hog Island, at the point of separation from Cooper River, is broad and deep, but gradually contracts in its course towards the lower harbor to five hundred yards in width; it then expands, and in its course to the bay, passes over extensive shoal, intersected by two channels.

There are forty-five feet water in this channel at low tide, from Cooper River to the gorge above mentioned; below this point, the depth gradually diminishes as the breadth increases. There is, however, water enough to admit any vessel that can enter the harbor. The marsh through which it passes is alluvial, and yields readily to the action of water. The city wharves which project into Cooper River about the point of separation, and the current from Town Creek, which enters diagonally from the opposite side, act conjointly in deflecting the water towards Hog Island Channel, and have, without doubt, caused the enlargement of its dimensions. There is reason to apprehend, that if measures are not taken to prevent it, this channel will become larger than that which passes the city, and that deposits of sand and mud, in front of the wharves, will follow as a necessary consequence.

The most respectable authority establishes, beyond dispute, that Hog Island channel pass, has been gradually increasing for many

years past. The causes which are supposed to have produced the enlargement of Hog Island channel, still exist; it cannot reasonably be expected, therefore, that their effects should cease, but rather continue to augment, until the worst fears of those interested are realized.

If these views are correct, delay will increase the expense of a work, which must ultimately be constructed.

In forming an opinion of the probable effects of partially or entirely closing Hog Island-pass, it will be useful to inquire what was the situation of the interior harbor, at a period when the channel was small, and received but little of the water of Cooper River. From the best information I have been able to procure, it appears that the depth of water opposite the city was then greater than it now is, and that the change has been effected by deposits of sand and mud.

The quantity of water flowing through Hog Island Channel has undoubtedly greatly increased, while that which passes the city has diminished, and the power of its current diminished in proportion. Each channel will adapt itself to the volume of water it is required to discharge; the one by wearing away the enclosing banks; the other, by its inability to remove them, will be obstructed by deposits.

It would seem to follow that the closing of Hog Island Channel, by restoring to the channel opposite the city, its original volume of water, will give it also its former dimensions.

From the effects already produced, and those that may be anticipated from the enlargement of Hog Island Channel, I am clearly of the opinion that it should be effectually closed.

In addition to those works already recommended for the improvement of Charleston Harbor, I beg leave to call the attention of the Department to another, which appears worthy of consideration. It is the construction of a breakwater from Cumming's Point to Fort Sumter. This work, in connection with the proposed breakwater over Drunken Dick Shoal, will add essentially to the security of the exterior harbor; will effectually protect the east side of James Island, and supersede the necessity of the work recommended for that purpose. Its location should be upon the shoal which extends from the point to the site of Fort Sumter.

In his Report, January 21st, 1842.

The preliminary survey of Drunken Dick Shoal being completed, I have the honor to submit herewith for the consideration of the Department, plans and estimates of the proposed dyke.

The objects to be attained are—First, additional security to Sullivan's Island and the site of Fort Moultrie.

Second, protection to the Harbor of Charleston from the effects of north-east gales.

The first well authenticated account of the encroachment of the sea upon Sullivan's Island which I have been able to find, relating to the period subsequent to that above referred to, viz. 1776, is that of

Von Hoff. Upon the authority of this writer, it appears that during the three years ending 1786, the sea carried away one-quarter of a mile of the beach. From that time forward, till 1830, when it reached and destroyed a portion of the walls of the present fort, its progress was more or less rapid, in proportion as the storms by which its destruction was chiefly effected were more or less severe.

The works commenced during the year last mentioned, for the protection of the site of Fort Moultrie, seem to have arrested the advance of the sea, and have since caused an increase of the beach.

The entire destruction of Sullivan's Island, would leave the Harbor of Charleston exposed to the unbroken violence of the sea. The great interest, manifested by the inhabitants in its preservation, has led to the investigation of the causes which have exercised a prejudicial influence upon it.

Amongst the most prominent assigned, may be mentioned the wharves of Charleston, the enlargement of Hog Island Channel, and the foundation of Fort Sumter.

It appears, however, that the tide from the "Cove," striking that from Hog Island, nearly at right angles, forces it off the shore. Observation has further shown that the destruction of beach is greatest during flood tide, which of course is independent of any influence from wharves and channels, four miles above the point of greatest decrement.

After a careful examination of the subject, I am unable to discover that the foundation of Fort Sumter has produced any perceptible effect.

But while doubting the agency of the supposed causes above referred to, it is with less confidence that I proceed to state what appears to me the true source of the degradation of the shores of this island. It has already been stated that it is during flood tide, with the wind on shore, that most injury is done to the beach; it is, therefore, to the ocean, and not to the harbor, we are to look for the source of mischief.

In general, the stability of a particular point on the sea-shore depends more upon the contour of coast, and the direction of the prevailing winds and currents, than upon the nature of the materials of which the coast is composed.

The wind from North-east, acting against the Gulf Stream, causes a high rise in the tide, and is always accompanied by a heavy sea, and a South-west current. The South and South-west winds, which frequently blow as violently as those from Northeast, throw in a heavy sea on the beach, at the point where the greatest injury has been done—has assumed the form it might be expected to take from the action of the waves during the Southwest gales, viz: a straight line of coast, nearly perpendicular to the direction of the winds. It is reasonable to suppose that the bar which encircles the entrance to this harbor, in the form of a crescent, arrests the sub-current, and that none but that which flows unbroken over the bar does any injury to the beach. This accords with my observation. I have not been able to satisfy myself that the shores of the island are wearing away to any great extent below this level.

Assuming, then, that the direction of prevailing winds and currents, and the contour of coast (all other things being equal), determine their stability, I proceed next to the consideration of the best means of counteracting the influence of those winds and currents which are believed to have caused the destruction of a portion of this island.

Two plans of the proposed work are herewith submitted, differing in nothing but position.

The first to consist of a grillage of Palmetto logs, loaded with rough granite, having the inner end resting on the shore, and extending along the crest of the shoal. The second to consist of a similar grillage, loaded in like manner, extending from the shoal perpendicularly to the rock which forms the bottom of the channel.

The first-proposed work would break the force of the waves which roll in upon the shore with great violence during storms.

From its position, however, it will be liable to all the fluctuations of the bar upon which it is placed, and may be washed away by some slight change in the direction of the currents by which that bar was formed (a change that in all probability may be effected by the breakwater), and would have less influence in arresting the sea which flows into the harbor during storms, than one located along the ground line.

The second plan, the adoption of which is respectfully recommended, it is believed will ultimately afford equal protection to the Curlew Ground, by causing the space between Drunken Dick Shoal and the shore to fill up, and will possess the advantage of greater security, having one end resting upon the works on shore, at the point where the sand is rapidly accumulating, and the other upon a rock bottom.

The direction of the work, according to this plan, will vary slightly from a North and South line, and will, therefore, be nearly perpendicular to the direction of the prevailing winds and currents: it will, consequently, be less liable to be undermined, while its position, with respect to the prevailing currents, will cause the greatest accumulation of sand.

REPORT OF LIEUT. KURTZ, CORPS OF ENGINEERS,

On the cost of dredging the Channel through the bulkhead across the Sullivan's Island Channel.

The following data are assumed as the basis of this estimate:

1. The deepening to be attempted by dredging machines, without the aid of artificial walls to contract the channel way.
2. The indications of the bottom render it probable, that such an excavation will be kept open by the current.

3. From the caving of the sides, and the flow of the tides, it is probable, that twice as much material will have to be removed as now occupies the space to be cleared.

4 From the exposure of the position, the machines cannot probably be kept at work more than half the time.

ESTIMATE.

Cost of dredging, 621,600 tons raised to an average height of twenty feet	\$24,864 00
Cost of maintaining vessels and crews while not at work	30,246 00
Cost of mud scows	1,800 00
“ “ cordage for hawsers	600 00
“ “ crews of scows	10,800 00
“ “ of dredge boats	18,000 00
Superintendent's wages	2,400 00
Clerks' “	1,200 00
Office hire, fuel, stationery and postage	475 00
Unforeseen expenses	9,038 00
	\$99,428 00

The cost of dredging a channel following the line c. d. will exceed the above by twenty-five per centum.

LETTER OF PRO. HOLMES OF CHARLESTON COLLEGE,
In relation to the Geographical Formations underlying Charleston Harbor.

CHARLESTON COLLEGE, MARCH 11TH, 1852.

Professor BACHE :

Dear Sir :—I beg herewith to submit for your examination, a geological map of the State of South Carolina, taken from a recent survey made by Professor Tuomey ; and also, for your perusal, a few notes descriptive of the geology of Charleston and the surrounding country, which I published a year or two ago. Especially would I claim your attention to the diagram annexed to the map, of a geological section extending from tide level at Charleston to the Saluda Gap, as from it, and some recent discoveries made in the marine beds, we hope to throw some light upon the structure of the “ bars ” at the entrance of Charleston harbor.

From actual surveys it has been ascertained that the great bed of marl, so extensively developed in South Carolina, and known to geologists as belonging to the eocene formation, underlies the city of Charleston, at the depth of about sixty feet, and out-crops, or comes to the surface, nine miles N. W., near Ashley ferry. About seven

miles North of East, in a nearly opposite direction, the superimposed beds, called Post Pliocene, are exposed upon or near the surface, thus placing Charleston a little to the East of the central axis of a small *basin* about sixteen miles wide. We say a basin, because, in addition to the out-crop and exposure of the marl, and its accompanying rocks inland, we frequently obtain from fishermen fine specimens of marl rock, dredged from the bar and the harbor, and often off the coast in twelve to fifteen fathoms, all of which specimens are quite characteristic of the eocene marl; and as it is well known that the "Northern," or "Sullivan's Island Channel," suddenly shoals from ten fathoms or sixty feet on the West, to one and a half fathoms or nine feet, and with a current at half ebb of say four knots, for the space of two hundred yards, when it as suddenly deepens to twenty-five feet, it seems reasonable to infer hence, that these obstructions are not caused by sand-bars, but are sub-marine escarpments of the marl rock, the representative of the Eastern ridge of the basin partially removed by the denuding action of the waves of the ocean.

I am, dear sir, most respectfully your obedient servant,
 Prof. A. D. BACHE. FRANCIS S. HOLMES.

*Letters from Capt. Peck, of the steamer William Seabrook,
 and of Mr. Adkins, Pilot of the Mail Steamer Marion.*

CHARLESTON, S. C., MARCH 17TH, 1852.

SINCE 1840, I have had continual experience in and about Charleston harbor and bar. I have made the following observations, viz.:

That the shoal ground between Fort Sumter and Fort Johnson has increased, forming a high bank, exposed at half ebb. This bank has thrown the body of the ebb towards Sullivan's Island.

The force of ebb and flood is much weakened when to the Southward and Westward of Cumming's Point buoy. I have observed that the main force of the tide in and out of Charleston harbor, is through the North and Sullivan's Island Channels; through the latter, on the ebb most forcibly, until Bowman's jetty is exposed.

I have examined the Coast Survey chart of Charleston harbor and bar, and find it full and complete in every respect. The proposed opening of Sullivan's Island Channel, I approve of highly, and think it the only spot on the bar where an experiment can be attempted with prospect of success. My reasons are as follows, viz.:

1st. All the channels South of Sullivan's Island are exposed to the ocean, and, consequently, are shifted more or less at every heavy blow. Moreover, the ebb is so dispersed that it has not the power to keep open the channels.

2d. The Sullivan's Island Channel is protected from the N. E. by the trending out of Long Island and Dewees' Inlet Shoal; from the Eastward by the Rattlesnake. In heavy N. E. blows, I have particularly observed that Sullivan's Island Channel was never affected by breakers, as is the case in the other channels. This is the only

protected channel on the bar, from Easterly and Northeasterly gales, and the Drunken Dick protects it in part from a S. E. blow.

In anything like a swell, fourteen feet in the Sullivan's Island Channel would be better than sixteen on the main bar. I have anchored off the bar: the flood sets direct to the breakers; the ebb from them.

It is my impression that if the belt which separates the inner curve of deep water from the outer curve of deep water is opened, that the action of the ebb will be sufficient to keep it open; for if the belt or bulkhead be removed, the ebb will flow through, whereas now it is bluffed off on the last quarter of the ebb.

FENN PECK,
Commanding Steamer William Seabrook.

To Prof. A. D. BACHE, and the gentlemen of the Board.

CHARLESTON, MARCH 13, 1852.

I have examined the Coast Survey Chart, and with pleasure attest to its perfect accuracy.

The proposition for dredging out the Sullivan's Island Channel, is to my mind a good one. *I know of no other part of the bar where an improvement can be attempted, with prospects of success.* In all ordinary blows, there is a smooth sea in the Sullivan's Island Channel.

SIMPSON ADKINS,
Pilot of Mail Steamer Marion.

To the Gentlemen of the Board for the Improvement of Charleston Bar.

DRAWINGS AND DOCUMENTS ACCOMPANYING THE REPORT.

With this report, the following named drawings and documents were submitted:

1. The Coast Survey Chart of Charleston Harbor and its approaches, from the survey of 1850-'51, scale $\frac{1}{10,000}$ prepared by request, for the use of the Chamber of Commerce of Charleston.
2. General Coast Survey Chart, showing the approach to Charleston Harbor.
3. Charts of the Tidal Currents of ebb and flood in Charleston Harbor, showing their direction and velocity.
4. Detailed Chart of Sullivan's Island Channel by the Coast Survey, 1851-'52, scale $\frac{1}{10,000}$.
5. Comparative Chart of Sullivan's Island Channel, before the construction of Bowman's jetty, and in 1851-'52.
6. Comparative Charts, showing the curves of 6 and 12 feet depth from the Charts of 1780 (Des Barrés,) Lieut. Sherburne and Maj. Bache.

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Report on the harbor of
Charleston

